Electrochemical deposition of different metals on few-layer graphene sheets for fuel cell applications

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Few-layer graphene (FLG) sheets are highly electrical conductive, have good chemical inertness and a high surface-to-volume ratio. These properties make them a promising candidate as building block and support material for electrical application of high interest like fuel cells and lithium-ion batteries. We have grown FLG sheets directly on conductive substrates (glass with 50 nm goldlayer, 4 cm^2) via plasma enhanced chemical vapor deposition at temperatures of ~ 650 °C with acetylene as carbon precursor.

The morphology of the FLG sheets was analyzed by SEM and Raman spectroscopy and was tuneable by chosing synthesis parameters.

Standard electrochemical deposition with aqueous metal salt solutions on FLG sheets is difficult and unfavourable because the very sharp edges of the structure would lead to inhomogeneous deposition of mainly large metal particles.

Therefore we have invented a non-aqueous method which allows electrochemical deposition of many different metals (e.g. Ni, Co, Bi, Cu, Ag, Pd, Au, Ti) as homogeneous dense (nano particle) layer even on FLG sheets. We have especially investigated samples with large silver nano particles for surface enhanced Raman spectroscopy and with a dense layer of small palladium nanoparticles as catalyst for fuel cell apllications.

Cyclovoltammetric (CV) measurements for ethanol oxidation in alkaline solution showed a very high catalyst activity, high cycle stability and current density for the FLG supported Pd nano particle layer. The loading of palladium catalyst was varied and could be correlated to its catalytic characteristics.

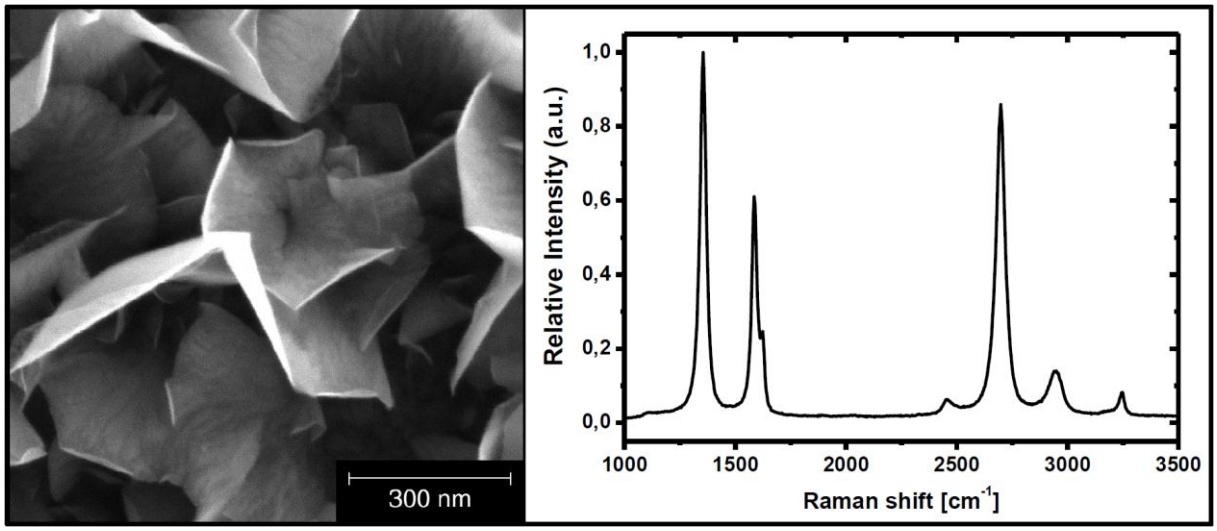

Figure 1: Typical SEM image and Raman spectrum of synthesized FLG sheets.

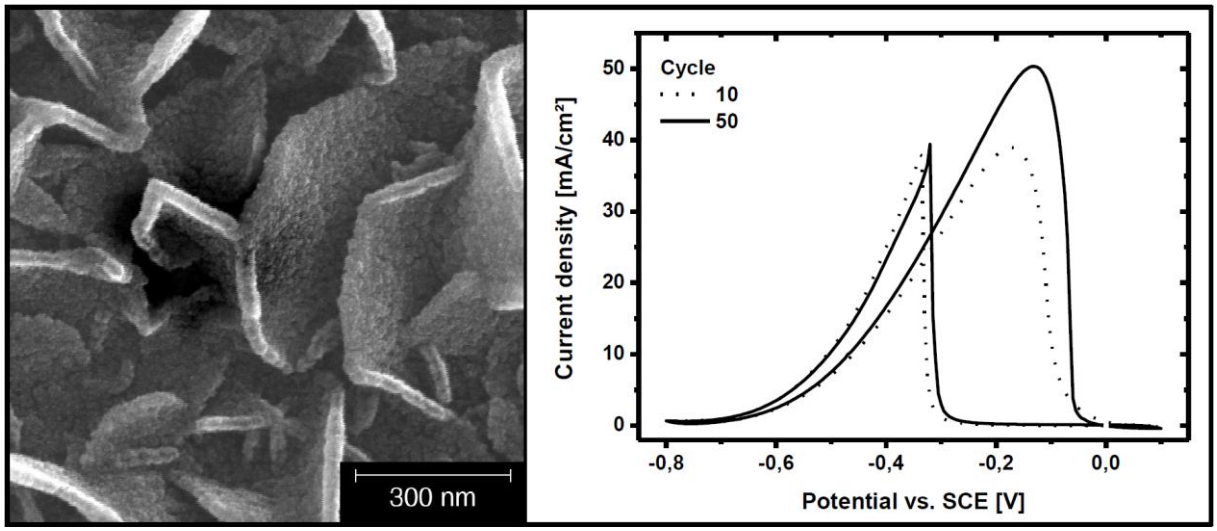

Figure 2: SEM image of FLG sheets densely covered with Pd nano particles and CV measurement of ethanol oxidation in alkaline solution (1 mol/L; 0.1 V/s scan speed).